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531,389

COMPLETE SPECIFICATION

Improvements in or relating to Bullets

I, ALBERT LEVERETT WOODWORTH, a citizen of the United States of America, of 69, Pinewoods Avenue, Springfield, Massachusetts, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to bullets.

Bullets of the type used in small arms have heretofore comprised cast lead or lead alloy, metal jacketed lead or lead alloy core structures and machined copper, brass or bronze bar stock. Such bullets are subjected to the rotating action of rifled barrels by which their rotative velocity is increased from zero to a substantially high rotative velocity in a very short period of time during the accompanying build-up of their muzzle velocity. During the use of such cast bullets, the permissible muzzle velocity and breech pressures are limited by the tendency of the lead to melt or strip under the action of the rifling. For high muzzle velocity purposes, metals harder and of higher melting point than lead are required. While the metal jacketed lead core bullets withstand stripping and melting at moderately high temperature, the lead cores thereof have been found to melt under the extremely high velocity conditions of the ballistic developments of recent years. The use of both the machined and metal jacketed lead core bullets results in an excessively high rate of barrel wear and erosion which extremely shortens the life of gun barrels, particularly those of rapid-fire machine guns.

Now it has been found that foraminous metal compositions prepared by sintering a compressed mixture of metal powders and which compositions have previously been used principally for bearings, are exceptionally well suited for making bullets which are free from the disadvantages associated with the jacketed lead or lead alloy, or the machined bullets just referred to. These foraminous metal compositions consist principally of powdered copper or other metal of high melting point the particles of which are bound together by intimately mixed particles of another powdered metal of low melting point, e.g. tin or lead, by compression followed by sintering, and they have been known for some time as is shown, for example, by British Patent Specifications Nos. 284,532 and 365,068.

The earlier of these two specifications states that, in a previously known form of bearing, metallic powders such as copper powder and tin powder are thoroughly mixed with finely divided graphite and a volatile void forming substance, such as salicylic acid (the volatile ingredient is not essential for the formation of voids). The ingredients should be sufficiently fine to pass through a 200 mesh screen, and are intimately mixed and briquetted into the desired form under high pressure, for example, 75000 pounds per square inch. The formed body is then heated in a non-oxidising atmosphere to a temperature sufficient to cause the metal particles to be joined together by alloying and to cause the volatile substance to be driven off from the body in order to leave minute voids which render the body porous and capable of absorbing lubricant. The specification then discloses an invention according to which porous metal bodies of this type are improved by adding a deoxidiser to the metal powder mixture and states that the improved metal bodies are suitable for use as bearings or other bodies intended to be used in rubbing contact with a relatively movable member. Reference is also made to the property of metal bodies of this type, in general, of absorbing quantities of lubricant which is supplied automatically to the surface of the metal body, for example in the case of a bearing. A method of causing the metal body to absorb lubricant by immersing it in heated lubricant oil, is also referred to.

The later specification also refers to an old method of making these metal compositions which consists in using metallic powders which will pass a 150 mesh screen dry and forming them under pressure into a coherent briquette which is then heated for varying periods of time, the metals

being alloyed at a temperature lower than that of the melting point of the main constituent metal. As an example of this known method a mixture of 84% copper, 10% tin, and 6% graphite is alloyed by sintering at a temperature of 1425° F. It is pointed out that this method has been used in making small bushings. The specification then discloses an invention which consists in improving such metal compositions by effecting the sintering with the aid of an electric current in the presence of a reducing or inert gaseous atmosphere and states that the invention relates to bearings or other articles composed of sintered metal particles and having minute communicating pores distributed throughout the mass adapted to contain lubricating material, and is stated to be applicable to the manufacture of bearings and other articles amongst which bushings, electric contact brushes and brake linings are specifically mentioned. It is also stated that it is an object of the invention to facilitate the manufacture of a bearing and to provide an article which will resist great crushing, pressures, and fracturing strains and which is of such strength that it may be made in large as well as small sizes. Reference is also made in this specification to the property of lubricant absorption which is possessed by these metal compositions.

Neither of these prior specifications, however, discloses the fact that these metal compositions have useful properties for making bullets, nor any application of these compositions in which the metal is subjected to such extreme condition as is the case with bullets in modern firearms where velocities of over 2500 feet per second, breech pressure of over 4500 lbs. per square inch and breech temperatures approaching 1000° C. obtain. None of these extreme conditions of relative speed, pressure and temperature are encountered or even approached in the applications of these metal compositions proposed in the two prior specifications referred to above. Furthermore it is to be noted that a bullet experiences a disruptive force as a result of the breech pressure, a type of stress absent in the applications of foraminous metal compositions previously proposed, for example, in bearings, which are supported in a block or backing which provides the strength to withstand disruptive forces.

Although metal compositions of the type referred to are advantageous in making bullets and it has been found the bullets so formed resist exceptionally well the disintegrating forces to which they are subjected in the firearm barrel and also cause less wear of the barrel, still further advantages can be obtained by causing the bullet to absorb lubricant in the known manner. This lubricant works to the surface of the bullet during firing, as a result of the influences to which the bullet is then subjected, and lubricates the firearm barrel thus further reducing the wear thereon. This reduction in barrel wear has very important advantages in maintaining the velocity and accuracy of the firearm during relatively long periods of use.

In accordance with the present invention, therefore, there is provided a bullet formed of a foraminous metal composition of the type herein referred to prepared by sintering a compressed mixture of metal powders.

More specifically stated, a bullet according to the present invention is formed of a foraminous sintered metal powder mixture of the kind herein referred to comprising powdered copper or copper alloy the particles of which are bound together by intimately mixed particles of another powdered metal of low melting point, e.g., tin, by compression in a mould followed by sintering in a reducing or non-oxidising atmosphere below the melting point of copper and above that of the bonding metal.

The bullet according to the present invention preferably contains absorbed lubricant.

One way of carrying the process of the present invention into practice is shown in the accompanying drawing in which Fig. 1 is a side elevational view of a bullet embodying the invention.

Fig. 2 is a transverse sectional view taken on the line 2—2 of Fig. 1.

Fig. 3 is a vertical sectional view diagrammatically showing a die suitable for the formation of bullets embodying the invention.

The improved bullet is made of a compressed mass of powdered metals of the known type already referred to in which is provided a substantial, thoroughly distributed void volume for the absorption and/or containing of lubricant. The lubricant is preferably of a liquid type but may in some instances comprise relatively solid material so long as it is present at the surfaces which engage the gun barrel during firing. The lubricant has such physical properties that it will be forced to the surface of the bullet by the conditions of temperature and pressure existing during the passage of the bullet through a gun barrel.

It has been found that bullets comprising a mixture of powdered copper and powdered tin which has been compressed

and then sintered at a temperature below the melting point of copper and above the melting point of tin in a known manner may be used very successfully in diverse types of guns including rapid-fire machine guns. Small quantities of powdered lead may be added to the powdered metal mixture, if desired, to increase the density and weight of the bullets. The following formula is an example of the known type of powdered metal composition which is particularly advantageous for the formation of bullets:

	Parts by weight
Powdered copper -	90
Powdered tin - -	10
Stearic acid - -	½
Boric acid - - -	½
Graphite - - -	1½

The bullet, generally designated by the numeral 10 in Figs. 1 and 2 is formed by briquetting a charge 11 of powdered metals in a die, illustrated at 12, under the action of a compressing ram 13. The die 12 is provided with a cavity 14 for receiving the powdered metal charge 11 and it has an axially extending passage 15 leading from the lower end of the cavity 14 for accommodating a plunger 16 by which the briquette resulting from compression of the powdered metal charge may be conveniently removed from the die. The briquette is then sintered in a non-oxidising or reducing atmosphere at a temperature of from substantially 1500° F. to 1550° F.

After the sintering operation, the bullet is preferably impregnated with liquid lubricant by immersing it while hot in the oil bath according to known practice. It is preferred to so limit the lubricant content of the bullet that its external surfaces will be free from lubricant wetted areas at all times except during firing of the bullet. This may be accomplished in any suitable manner either by limiting the amount of lubricant introduced into the metal mass or by substantially saturating the lubricant absorbing capacity thereof and subsequently removing a portion of the absorbed lubricant by heating the oil impregnated bullet sufficiently to expel some of the lubricant which may be blotted or wiped off. The total absorbed lubricant content can be varied by varying the porosity of the bullet, as, for example, by altering compression, size of particles and other void forming factors.

Porous, compressed and sintered powdered metal bullets of the foregoing character have an exterior portion which is hard enough to withstand stripping by the rifling of a gun barrel. By controlling the quantity of oil contained therein, the introduction of dangerously large amounts of lubricant into a gun is successfully guarded against while assuring proper lubrication of the passage of the bullets through the gun barrel during firing thereof for the self-contained lubricant is forced through the porous structure of the bullet by the pressure to which it is subjected during firing as well as by the expansion of the lubricant resulting from the firing temperatures. The density of bullets of this character can be conveniently varied by varying the force of compression, the size of the particles of powdered metal and the type and proportions of powdered metals employed.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A bullet formed of a foraminous metal composition of the type herein referred to prepared by sintering a compressed mixture of metal powders.

2. A bullet formed of a foraminous sintered metal powder mixture of the kind herein referred to comprising powdered copper or copper alloy the particles of which are bound together by intimately mixed particles of another powdered metal of low melting point, e.g., tin, by compression in a mould followed by sintering in a reducing or non-oxidising atmosphere below the melting point of copper and above that of the bonding metal.

3. A bullet according to claim 1 or 2, including a charge of absorbed lubricant in the interior thereof.

4. A bullet according to claim 3, in which said charge of absorbed lubricant is of less quantity than the equivalent absorptive capacity of the bullet at atmospheric temperatures and pressures, the external surface of said bullet being normally substantially free from lubricant wetted areas under said temperature and pressure conditions.

5. A bullet according to any of claims 2 to 4 which also includes powdered lead as a constituent of the metal powder mixture.

6. A bullet, substantially as herein-before described.

Dated this 29th day of March, 1939.

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531,389 COMPLETE SPECIFICATION 1 SHEET

Fig. 1.

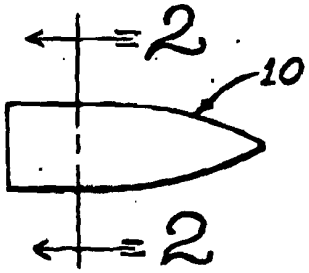


Fig. 2.

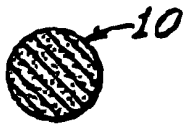
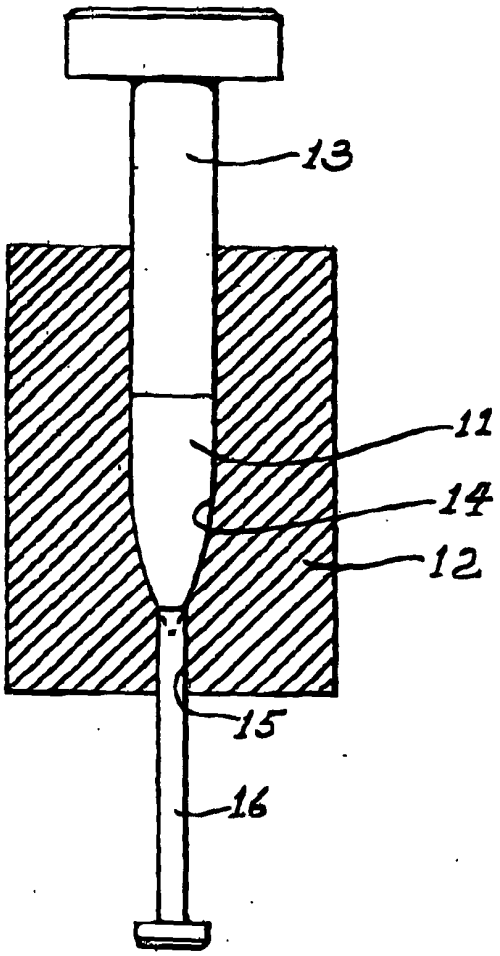


Fig. 3.



[This Drawing is a full-size reproduction of the Original.]

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